

CLAIMS:

1. A method for determining the occurrence of an apnea in a patient, the method comprising the steps of:
  - 5 measuring respiratory air flow from the patient as a function of time;
  - determining the variance of said measured air flow; and
  - determining from said variance that an apnea is occurring.
- 10 2. A method as claimed in claim 1, wherein said variance is a moving average over said time window.
3. A method as claimed in claim 2, comprising the further step of
  - 15 comparing said variance with a threshold value, and if said variance falls below said threshold value then an apnea is occurring.
4. A method as claimed in claim 3, wherein said measured air flow is
  - 20 expressed as an air flow signal.
5. A method as claimed in claim 4, wherein said step of measuring includes sampling said respiratory air flow at equally spaced points in time to give a
  - 25 sampled air flow signal.
6. A method as claimed in claim 3, wherein, in said comparing step, said variance must fall below said threshold value for a predetermined period of time before
  - 30 it is determined that an apnea is occurring.
7. A method as claimed in claim 3, comprising the further step of either commencing continuous positive airway pressure (CPAP) treatment or increasing CPAP
  - 35 treatment pressure to the patient if an apnea is occurring.
8. A method for detecting partial obstruction of the airway of a patient,

the method comprising the steps of:

- measuring respiratory air flow from the patient;
- detecting the inspiratory part of said air flow;
- normalising said inspiratory part; and
- 5 determining an index value of a mid-portion of said normalised inspiratory part  
as a measure of partial obstruction.

9. A method as claimed in claim 8, wherein said index value is  
10 determined from the amplitude of said mid-portion of said normalised inspiratory part.

10. A method as claimed in claim 9, wherein said index value is  
determined as the arithmetic mean value of said amplitude in said mid-portion.  
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11. A method as claimed in claim 8, wherein said index value is  
determined from:  
the flatness of said mid-portion of said normalised inspiratory part.  
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12. A method as claimed in claim 11, wherein said index value is  
determined as the root mean square (RMS) deviation of said normalised inspiratory part  
in said mid-portion with respect to unity.  
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13. A method as claimed in claim 8, wherein said normalising includes  
scaling said inspiratory part to unity duration and unity area.

14. A method as claimed in claim 8, wherein said determination is  
performed over a plurality of inspiratory events.  
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15. A method as claimed in claim 8, comprising the further step of either  
commencing CPAP treatment or increasing CPAP treatment pressure to the patient if  
there is partial obstruction of the airway.  
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16. A method for determining the degree of obstruction of the airway of a patient receiving continuous positive airway pressure (CPAP) treatment by apparatus for supplying CPAP to the patient's airway, the method comprising the steps of:

5       measuring respiratory air flow from the patient to give an air flow signal;  
      filtering said air flow signal to reject components at least due to respiration to give a filtered air flow signal having components due to patient snoring and noise of said CPAP apparatus;

      predicting a CPAP apparatus noise component of said filtered air flow signal;  
10     and

      subtracting said predicted noise component from said filtered air flow signal to give a snore component signal as a measure of the degree of obstruction of the airway.

15       17. A method as claimed in claim 16, wherein the filtering step includes bandpass filtering also to reject high frequency noise components.

      18. A method for determining patency of the airway of a patient, the  
20     method comprising the steps of:

      applying an oscillatory pressure waveform of known frequency to the patient's airway;

      measuring respiratory air flow from the patient; and

      determining that the airway is patent if there is a component of said air flow at  
25     said known frequency induced by said oscillatory pressure waveform.

      19. A method as claimed in claim 18, wherein said air flow component is determined from the amplitude of said air flow signal, and comprising the further step  
30     of comparing said magnitude with a threshold value, and if said magnitude is greater than said threshold value then the airway is declared patent.

      20. A method for determining the degree of patency of the airway of a  
35     patient, the method comprising the steps of:

      applying an oscillatory pressure waveform of known frequency and magnitude to the patient's airway;

      measuring respiratory air flow from the patient;

determining the magnitude of the component of said air flow at said known frequency induced by said oscillatory pressure waveform; and

determining the degree of patency as the ratio of said induced air flow magnitude and said oscillatory pressure waveform magnitude.

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21. A method as claimed in claim 18, wherein said measured air flow is expressed as an air flow signal.

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22. A method as claimed in claim 18, performed when the patient is asleep.

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23. A method as claimed in claim 22, performed when it previously has been determined that the patient is having an apnea.

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24. A method for determining patency of the airway of a patient, the method comprising the steps of:

measuring respiratory air flow from the patient; and

analysing said measured air flow to detect the presence of cardiogenic air flow, and if said cardiogenic air flow is present then the airway is declared patent.

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25. A method as claimed in claim 24, wherein said measured air flow is expressed as an air flow signal.

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26. A method as claimed in claim 25, wherein the respiratory air flow is high pass filtered to reject components due to respiration.

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27. A method as claimed in claim 26, wherein said analysing step detects the presence of a periodic component.

28. A method as claimed in claim 27, wherein said analysing step further

includes performing a Fourier transformation on said air flow signal.

29. A method as claimed in claim 24, comprising the further step of  
5 detecting the patient's cardiac rate, and whereby the analysing step includes detecting a component of said air flow at the cardiac rate.

30. A method for controlling the administration of CPAP treatment to the  
10 airway of a patient by means controllable to supply breathable air to the patient's airway continually at a selectable pressure elevated above atmospheric pressure, the method comprising the step of:

commencing or increasing CPAP treatment pressure if:

(a) an apnea is occurring, determined by the steps of:  
15 measuring respiratory air flow from the patient as a function of time; and determining the variance of said measured air flow as an indication of an apnea occurring;

or (b) there is partial obstruction of the airway, determined by the steps of:  
measuring respiratory air flow from the patient;  
20 detecting the inspiratory part of said air flow;  
normalising said inspiratory part; and determining an index value of a mid-portion of said normalised inspiratory part as a measure of partial obstruction;

or (c) there is patency of the airway, determined by the steps of:  
25 (i) applying an oscillatory pressure waveform of known frequency to the patient's airway;  
measuring respiratory air flow from the patient; and determining that the airway is patent if there is a component of said air flow at said known frequency induced by said oscillatory pressure waveform;  
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or (ii) measuring respiratory air flow from the patient; and analysing said measured air flow to detect the presence of cardiogenic air flow, and if so then the airway is declared patent.

31. A method as claimed in claim 30, comprising the further step of  
35 reducing CPAP treatment pressure if:

by step (a) it is determined there is no apnea occurring and by step (b) it is

determined that there is no partial obstruction; or

by step (a) it is determined that there is an apnea occurring and by step (c) it is determined that the airway is not patent.

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32. Apparatus for determining the occurrence of an apnea in a patient, the apparatus comprising:

means for measuring respiratory air flow from the patient as a function of time;

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means for determining the variance of said measured air flow; and

means for determining from said variance that an apnea is occurring.

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33. Apparatus for detecting partial obstruction of the airway of a patient, the apparatus comprising:

means for measuring respiratory air flow from the patient;

means for detecting the inspiratory part of said air flow;

means for normalising said inspiratory part; and

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means for determining an index value of a mid-portion of said normalised inspiratory part as a measure of partial obstruction.

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34. Apparatus for determining the degree of obstruction of the airway of a patient receiving continuous positive airway pressure (CPAP) treatment by means for supplying CPAP to the patient's airway, the apparatus comprising:

means for measuring respiratory air flow from the patient to give an air flow signal;

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means for filtering said air flow signal to reject components at least due to respiration to give a filtered air flow signal having components due to patient snoring and noise of said CPAP apparatus;

means for predicting a CPAP apparatus noise component of said filtered air flow signal; and

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means for subtracting said predicted noise component from said filtered air flow signal to give a snore component signal as a measure of the degree of obstruction of the airway.

35. Apparatus for determining patency of the airway of a patient, the

apparatus comprising:

means for applying an oscillatory pressure waveform of known frequency to the patient's airway;

means for measuring respiratory air flow from the patient; and

5 means for determining that the airway is patent if there is a component of said air flow at said known frequency induced by said oscillatory pressure waveform.

10 36. Apparatus for determining the degree of patency of the airway of a patient, the apparatus comprising:

means for applying an oscillatory pressure waveform of known frequency and magnitude to the patient's airway;

means for measuring respiratory air flow from the patient;

15 means for determining the magnitude of the component of said air flow at said known frequency induced by said oscillatory pressure waveform: and

means for determining the degree of patency as the ratio of said induced air flow magnitude and said oscillatory pressure waveform magnitude.

20 37. Apparatus for determining patency of the airway of a patient, the apparatus comprising:

means for measuring respiratory air flow from the patient; and

25 means for analysing said measured air flow to detect the presence of cardiogenic air flow, and if said cardiogenic air flow is present then the airway is declared patent.

38. Apparatus for controlling the administration of CPAP treatment to the airway of a patient comprising

30 means controllable to supply breathable air to the patient's airway continually at a selectable pressure elevated above atmospheric pressure;

controlling means for commencing or increasing CPAP treatment pressure if:

(a) an apnea is occurring, determined by:

35 measuring respiratory air flow from the patient as a function of time; and

determining the variance of said measured air flow as an indication of an apnea occurring;

or (b) there is partial obstruction of the airway, determined by:

measuring respiratory air flow from the patient;

detecting the inspiratory part of said air flow;  
normalising said inspiratory part; and  
determining an index value of a mid-portion of said normalised inspiratory part  
as a measure of partial obstruction;

5 or (c) there is patency of the airway, determined by:

(i) applying an oscillatory pressure waveform of known frequency to  
the patient's airway;

measuring respiratory air flow from the patient; and

determining that the airway is patent if there is a component of said air

10 flow at said known frequency induced by said oscillatory pressure  
waveform;

or (ii) measuring respiratory air flow from the patient: and

analysing said measured air flow to detect the presence of cardiogenic air  
flow, and if so then the airway is declared patent.